From:	Fleer, James
To:	Tzhone, Stephen; Moix, Mark
Cc:	Tom Aley; shiloh@ozarkundergroundlab.com; Ungvarsky, Carole; John Edgcomb
Subject:	Comments and issues regarding Arkwood future work thoughts
Date:	Wednesday, November 25, 2015 4:56:31 PM

Stephen/Mark,

As we recently discussed, we have reviewed the comments regarding the Supplemental Groundwater Tracing Summary Report dated March 2015 and the supplemental discussion of EPA's and ADEQ's concerns related to groundwater flow and movement and contaminant transport. Specifically, EPA and ADEQ have requested several items of additional work which pose significant implementation issues. These items are discussed below.

- Perform an additional dye test at a time of high flow through the karst system which would occur at or near the time of peak discharge from New Cricket Spring.
  - Issue – we can work to design a dye test during or immediately after a "significant" storm event. Identifying the presence of a significant or significantly adequate storm event poses a unique challenge. In addition, there are multiple issues with worker safety associated with performing this during a storm event (lightning, heavy winds, etc.).
    - Possible solution/alternative: we can propose conditions expected to result in a storm event that will result in "high flow" conditions but avoid a severe storm event (i.e., lightning events and heavy winds). Because storm events are unpredictable, we suggest having pre-determined minimum criteria defining a high flow/peak event (i.e., a minimum rainfall amount as measured at a regional weather station (we suggest one-quarter inch or greater - due to the surface area in proximity to the Site and the rapid response from the Site to New Cricket Spring, it does not require a significant amount of rainfall to generate significant flow at New Cricket Spring) or a specified flow rate measured at New Cricket Spring (we suggest a minimum of 100 gpm)). We expect the flow rate criteria to be a better determinant of the "quantification" that an event was a "high flow/peak" event.
  - Issue – Note – during the recent dye trace study, dye was detected at New Cricket Spring within four to eight hours after injection and the peak concentration was observed eight to twelve hours after introduction. In addition, a high flow condition will result in water volumes at New Cricket Spring which exceed the capacity of the treatment system resulting in dye by-passing the treatment system. During the previous dye trace, the treatment system effectively treated much of the dye but a small amount of dye was identified at Cricket Pond (a pond fed by the effluent from New Cricket Spring and Cricket Spring – separate monitoring of Cricket Spring determined the dye was not sourced from Cricket Spring). During a "peak" or high flow dye injection, much more of the dye emanating from New Cricket Spring would not be removed by the treatment system (simply due to the capacity of the system and the volume of water encountered at the

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mouth of the spring). Much/Most of the dye surfacing at New Cricket Spring would then flow across the surface ditches to Cricket Pond and beyond. The surface ditches and Cricket Pond/Cricket Creek will then represent new dye introduction points which cannot be controlled. The origin of any dye identified after the first detection at New Cricket Spring will be from an unknown source and cannot be reliably assigned to the Site or subsurface conditions at the Site.

        - Possible solution/alternative: add an additional dye at the mouth of New Cricket Spring. If the additional dye is detected, the source would be attributed to New Cricket Spring or downstream water courses and not the Site.

- Collect water samples during peak flow conditions from identified seeps and discharges along Old Cricket Road across from the treatment plant northwest of the site, along railroad track north of the site, and inside the railroad tunnel northeast of the site.
    - Issue – we are concerned that any samples collected from seeps or discharges during peak flow conditions will be significantly impacted by sediments surrounding the seep (cannot segregate seep flow from the sediment/soil along the seep location) and "discharges" along Old Cricket Road or other locations will be adversely impacted by turbulent overland flow commingling with any potential flow from seeps. Not knowing the construction of the railroad tunnel spring, this concern also extends to the tunnel location. I have never visited the railroad tunnel spring but have been told the spring is essentially water producing at a tunnel joint. During heavy rains, I am told the joint is under pressure such that the "spring" is a series of "fountains" emanating from the joint. Thus we have similar concerns regarding the impact of turbulence at the railroad tunnel spring. With a regulatory criteria of 30 part per quadrillion, any influence or interference from sediments or surface soils (including adverse impacts on the detection limit) would be significant.
        - Possible solution/alternative: None. Does EPA have any sampling protocols/procedures to effectively separate sediments from essentially "film flow" from a seep or to mitigate the impacts of turbulent overland flow in assessing colloidal systems? Is some form of filtration acceptable?
    - Issue – Also, the railroad tunnel is approximately one-half mile long (2,657 feet long) and the railroad tunnel spring is located a significant distance into the tunnel. The railroad line is owned by Union Pacific but apparently several railroads use the track. There have been reports of historical issues with coordinating sampling events and train schedules. Sampling this location may present significant personnel hazards.
        - Possible solution/alternative: In addition to obtaining train schedules and informing the railroad operators of our activities and schedules, we can establish spotters along the tracks at distance to provide adequate notifications (assumes radio or cellular traffic is viable in

the area (coverage appears spotty and untrustworthy) or inside the tunnel (will likely require additional personnel at the tunnel entrances to verify notification or provide an emergency notification (blast horn or similar))).

- Implement monitoring well(s) at depth, as well as, shallow monitoring wells north of and/or at lower elevations than New Cricket Spring.
  - Issue – the ROD for the site documents the results of deep aquifer analysis and historical attempts to establish a shallow groundwater monitoring program. The ROD states:

    The area is underlain by karst geology which prevents the use of monitoring wells as a method of predicting contaminant movement, or recovery wells as a method of remediation. (page 2 of declarations)

    Ground water flow occurs by one of two primary methods in a karst environment; flow along fine fractures and bedding planes, and turbulent conduit flow along solutionally enlarged pathways. If monitoring or recovery wells are drilled into karst geology, three general flow scenarios are possible. First, the well could be dry, having not intercepted either fractures or conduits. Second, the well may intercept small fractures bearing low flow rates of groundwater with the well having a very small area of influence (i.e. on the order of feet). Third, the well could intercept a conduit, possibly resulting in high pumping rates. However, it is not possible to predict where to drill in order to intercept these conduits. This was demonstrated during the Arkwood RI, in which two wells drilled on site were dry, and the rest had very low production rates. No conduits that transmitted substantial water were encountered. (page 7);

    <u>Shallow Aquifer Classification</u>

    The shallow karst aquifer beneath the site may be classified as a Class IIb aquifer. While it is not currently used as a drinking water source, similar water-bearing units that discharge to springs in the area are. The base flow of 15 gpm also classifies the aquifer as Class IIb based on the "sufficient flow" criteria[3]. This particular part of the shallow karst aquifer is closely connected to the surface, has no apparent connection with deeper, water supply aquifers, and is not currently being used as a drinking water supply. (page 9);

    <u>Deep Aquifer</u>

    There appears to be no connection between the shallow karst aquifer and deeper water supply aquifers. The water chemistry has been demonstrated as being sufficiently different to confirm this lack of connection. (page 9); and,

    Additionally, a shallow unit (the Sylamore Sandstone) appears to act as an aquiclude, restricting downward migration of the shallow ground water in the vicinity of the site. Almost all of the 54 springs in the area discharge above the Sylamore sandstone. No ground water in the deeper producing zones has been detected to have contamination. This evidence, along with the lack of water in the Powell and Cotter formations indicates that shallow ground water that occurs near the site does not recharge the deeper water bearing units used for drinking water. (page 11).

  - Possible solution/alternative: As we discussed, we can potentially look to identify a very limited number of strategic location(s) for shallow well(s) and we can sample the deep well located on the Site (which has been pumped from time to time over the last 20 years and is used on a very limited basis for day-to-day water needs). We cannot make a reliable prediction that any location at or near the Site (strategic location or otherwise) will be hydraulically connected to the dye injection location or representative of groundwater or groundwater flow. Ultimately, the issue is if dioxin is migrating to an exposure point at concentrations of concern. As we discussed, we have significant historical evidence identifying the points (local springs) where chemicals of concern for the Site were identified prior to remediation of the Site. After site remediation activities, those concentrations faded to non-detectable levels. At that time, these locations were not sampled for dioxin. Assuming a satisfactory method for sampling can be identified that addresses our concerns related to turbidity (as opposed to “natural colloidal migration”), drilling effects, or effects of turbulence, we can sample the well location(s) for dioxin concentrations.
- Issue – We have concerns similar to the concerns associated with seeps and discharges; that potential turbidity in any shallow wells may adversely influence the determination of a true colloidal dioxin concentration. Again, with a regulatory criteria of 30 part per quadrillion, any influence or interference from turbidity (including adverse impacts on the detection limit) would be significant.
  - Possible solution/alternative: None. Does EPA have any sampling protocols/procedures to effectively mitigate the impacts related to turbidity (as opposed to “natural colloidal migration”), drilling effects, or effects of turbulence in assessing colloidal systems? Is some form of filtration acceptable?

We look forward to the opportunity to discuss these issues and their resolution with you further. I would appreciate feedback on the issues discussed above and an opportunity for our teams to discuss possible resolution to these issues to adequately address EPA’s and ADEQ’s remaining concerns in the near future.

Best Regards,

Jim

James Fleer

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